2016 Building Energy Efficiency Standards

ACM Workshop

The Draft PV Credit

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2016 Standards

The 2016 Standards were adopted by the Commission on June 10, 2015

The Residential Standards included four main measures:

- High Performance Attics (HPA)
- High Performance Walls (HPW)
- Instantaneous (Tankless) Water Heaters
- High Performance Lighting and Controls

2016 Residential Standards Vision

2016 Standards Built Upon the Past Experience

1. ZNE goal requires consideration of measures that represent a significant change in construction practice
2. The 2013 Standards rulemaking list of measures included High Performance Attic (HPA) and High Performance Walls (HPW), measures needed to improve the efficiency of the building envelope
3. However, these measures were abandoned because at the time they did not have the support of the building industry:
   - The measures were a significant departure from the common building construction practice
   - Required re-training of the trades workers
   - Cost effectiveness measures did not demonstrably exist at the time
4. Staff recognized at the beginning of the 2016 standards development process that accomplishing HPA and HPW would be very challenging and require close collaboration with industry stakeholders at all levels (builders, manufacturers, and suppliers) to achieve.

2016 Residential Standards Vision

The 2016 Standards Approach:

To make HPA and HPW a reality under the 2016 Standards staff considered the following steps

1. Not focused on specific measures: instead, staff defined performance targets, such as U-factors, needed to meet the ZNE goals
2. Invited builders, manufacturers, and suppliers to partner with staff to come up with solutions that meet equivalent performance
3. CBIA hosted forums in April and November of 2014 to communicate the ZNE vision and engage industry in creating new solutions – allowing the free market to settle on the most promising solutions
4. Worked with the CPUC and IOUs to establish a targeted program, including incentives and builder team facilitation, to transition builders to the new practices, and with the EPIC program to provide workforce development, needed for these solutions in advance of the effective date
5. Propose a limited PV tradeoff thru the ACM process to provide some builders the time needed to transition to HPA and HPW

The result was a cooperative and innovative collaboration between the Commission, builders, manufacturers, CPUC, and utilities. The industry as a whole rose to the challenge with multiple solutions for both HPAs and HPWs.

2016 Standards Range of Options

High Performance Attics (HPA) performance defined by:

Roof deck insulation equivalent to R-13 insulation below deck and R-38 ceiling insulation. Insulation choices may include spray foam, batt, or blown-in

However, the builder has many other options, all meeting the HPA performance:

1. R-6 continuous insulation with radiant barrier
2. Hybrid roofing systems combining insulation and higher roof reflectance
3. Ducts in conditioned space (DCS)
4. Ducts in sealed or unvented attics
5. SIP panels
6. Or other solutions suggested by the industry

2016 Standards Range of Options

2016 Standards Range of Options

High Performance Walls (HPW) – Performance Defined By:

R19 cavity + R5 Continuous Insulation – U-Factor of 0.051

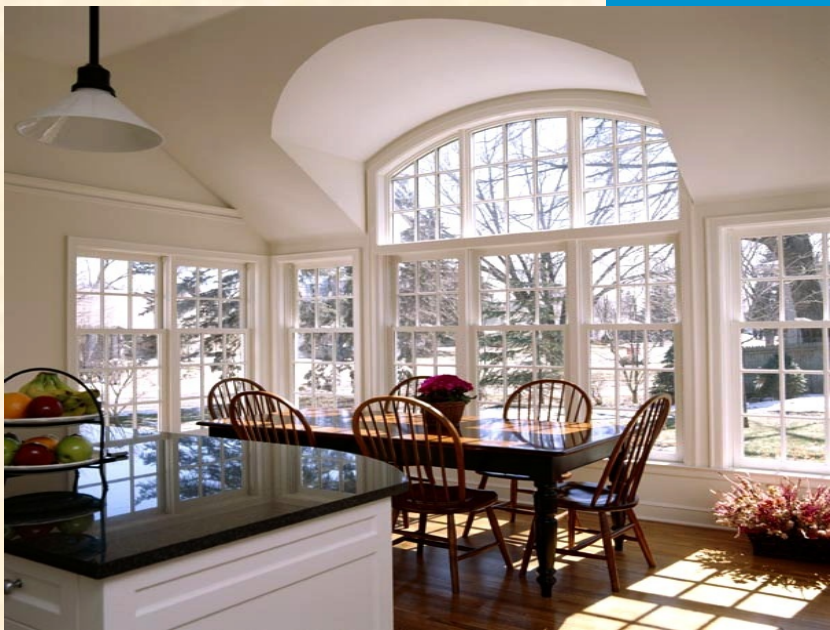
However, the builder has many other options, all meeting the HPW performance:

1. 2x4 @ 16" OC, R15 + R-8 CI (0.051)
2. 2x6 @ 24" OC, R19 + R-5 CI (0.049)
3. 2x6 @ 24" OC R21 + R-4 CI (0.048)
4. Staggered studs with batt insulation or spray foam
5. Structurally Insulated Panels (SIPs)
6. Or other solutions suggested by the industry

2016 Standards Range of Options

Or choose a compliance option to comply with the 2016 Standards:

- A limited, flexible photovoltaic compliance option proportional to the HPA and HPW, usable under the performance approach for other building measures
- Other compliance options, include among others, high performance windows and high EER air conditioning systems



The Draft PV Credit

1. The software determines the standard design for HPA and HPW based on building size & climate zone
2. The size of the PV credit would be limited to just trade away HPA and HPW
3. Would only be available in CZs where either HPA, HPW, or both are prescriptively required
4. A minimum of 2 kW PV system would be required in homes that are 2,000 square feet or less; for homes larger than 2,000 square feet, the PV size would be increased based of the size of the home and CZ
5. The credit would be "flexible", meaning it could be used to trade away other building features, such as additional west-facing glass; however, in that event, the entire credit would not be available to offset the HPA and HPW

Title 24
2016
Standards

The Draft PV Credit

- The proposed credit would allow the builders who are not familiar with HPA or HPW construction practices additional time to adjust to the new market conditions
- Even if the builder uses the proposed PV credit to trade away the HPA and HPW, the building is still more energy efficient than a 2013 compliant building:
  - The building still would have the equivalent of the 2013 envelope prescriptive requirements, including R-38 ceiling insulation and R15+4 wall insulation
  - Would be required to install instantaneous (tankless) water heaters
  - Would be required to install all high efficacy lighting and controls throughout the house

The Draft PV Credit

- With less than 18 months to go before the effective date, many production builders are already experimenting with various HPA techniques, taking advantage of incentives provided by the utilities
- Some of these builders have collected more than a year's worth of performance and moisture data, and so far it seems promising
- As more builders gain experience with HPA and HPW, others will find HPA and HPW solutions that work for their companies in order to stay competitive

- Builders and manufacturers should continue to innovate and create new cost effective products and techniques that meet the HPA and HPW performance levels
- For the 2019 Standards, it is expected to remove the PV credit if cost effective HPA and HPW products are widely available to the builders

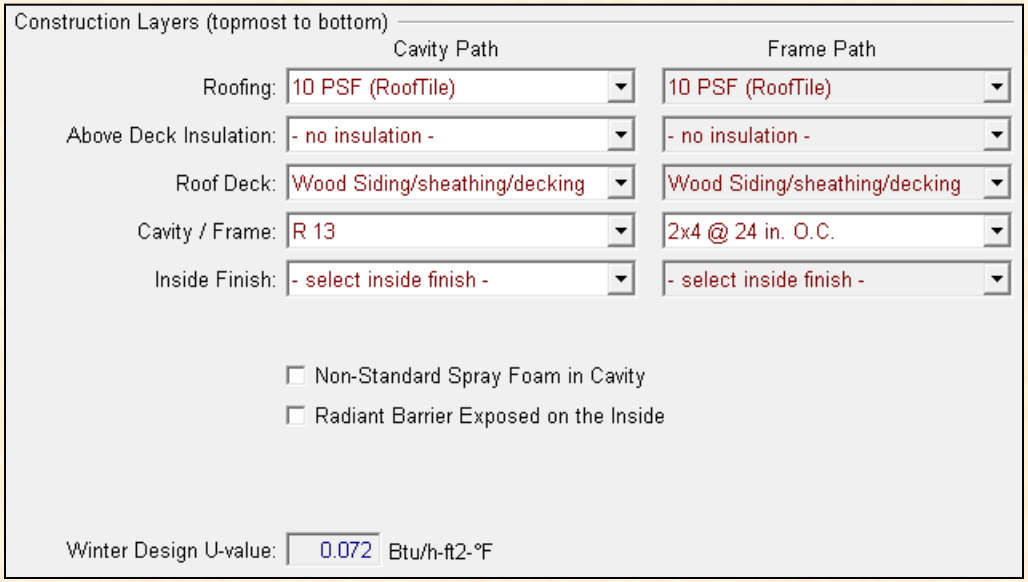
The Draft PV Credit – How It Would Work

The following simulations are based on:

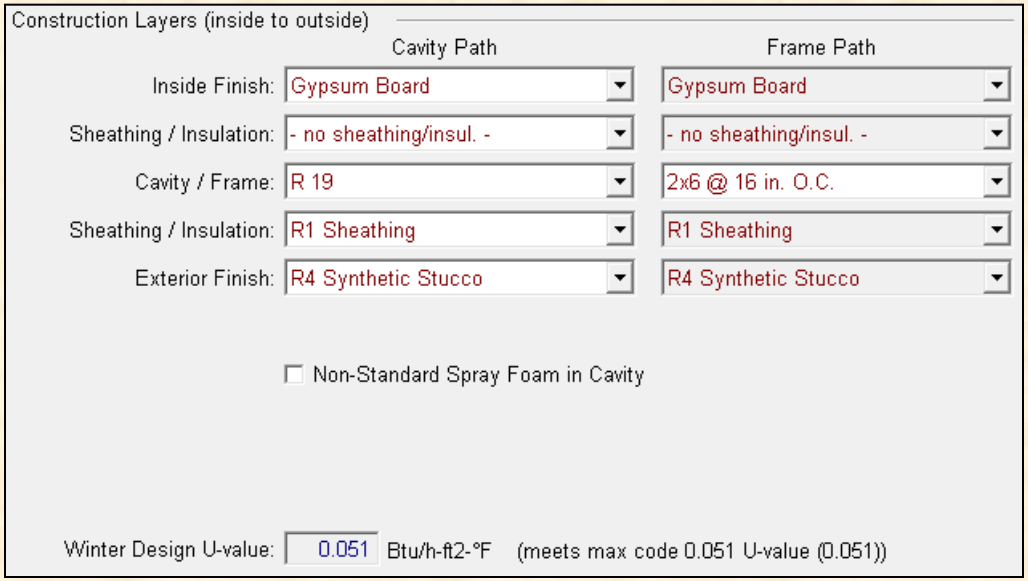
- 2,700 square feet 2-story prototype
- Vented Attic
- Ducts in unconditioned space (Attic)
- Climate zone 12
- 5% total duct leakage
- R8 duct insulation

The Draft PV Credit – How It Would Work

Option 1, builder complies with HPA and HPW, no PV Credit



HPA Construction – included R13 cavity insulation



HPW Construction – R19 + R5 CI

Title 24 2016 Standards

The Draft PV Credit – How It Would Work

Option 1, builder complies with HPA and HPW, no PV Credit

End Use	Standard Design Site (kWh)	Standard Design Site (therms)	Standard Design (kTDV/ft²-yr)	Proposed Design Site (kWh)	Proposed Design Site (therms)	Proposed Design (kTDV/ft²-yr)	Compliance Margin (kTDV/ft²-yr)
Space Heating	192	224.1	16.94	192	224.1	16.94	0.00
Space Cooling	549		16.17	549		16.17	0.00
IAQ Ventilation	141		1.15	141		1.15	0.00
Other HVAC			0.00			0.00	0.00
Water Heating		134.2	8.29		134.2	8.29	0.00
PV Credit						0.00	0.00
Compliance Total			42.55			42.55	0.00
Inside Lighting	1,300		11.11	1,300		11.11	- %
Appl. & Cooking	1,023	60.4	12.08	1,023	60.4	12.08	Result:
Plug Loads	2,630		21.67	2,630		21.67	PASS
Exterior	161		1.20	161		1.20	
TOTAL	5,996	418.6	88.61	5,996	418.6	88.61	

The building just complies

Title 24
2016
Standards

The Draft PV Credit – How It Would Work

Option 2, no HPA and no HPW, no PV Credit

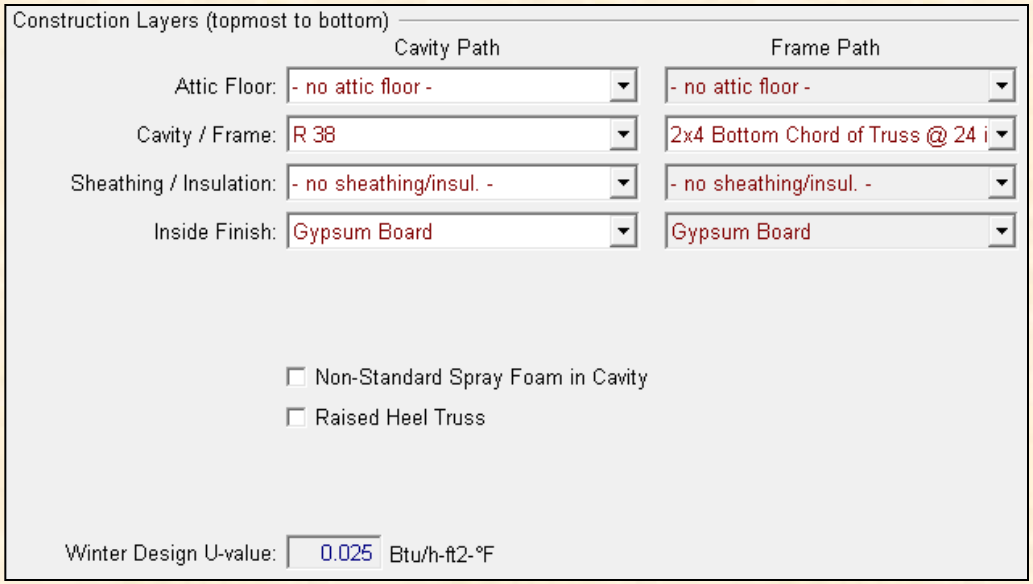
End Use	Standard Design Site (kWh)	Standard Design Site (therms)	Standard Design (kTDV/ft²-yr)	Proposed Design Site (kWh)	Proposed Design Site (therms)	Proposed Design (kTDV/ft²-yr)	Compliance Margin (kTDV/ft²-yr)
Space Heating	192	224.1	16.94	228	265.8	20.07	-3.13
Space Cooling	549		16.17	732		21.95	-5.78
IAQ Ventilation	141		1.15	141		1.15	0.00
Other HVAC			0.00			0.00	0.00
Water Heating		134.2	8.29		134.2	8.29	0.00
PV Credit						0.00	0.00
Compliance Total			42.55			51.46	-8.91
							-20.9 %
Inside Lighting	1,300		11.11	1,300		11.11	
Appl. & Cooking	1,023	60.4	12.08	1,023	60.4	12.08	Result:
Plug Loads	2,630		21.67	2,630		21.67	FAIL
Exterior	161		1.20	161		1.20	
TOTAL	5,996	418.6	88.61	6,215	460.4	97.52	

The Building fails by a margin of more than 8 TDV/ft2-yr

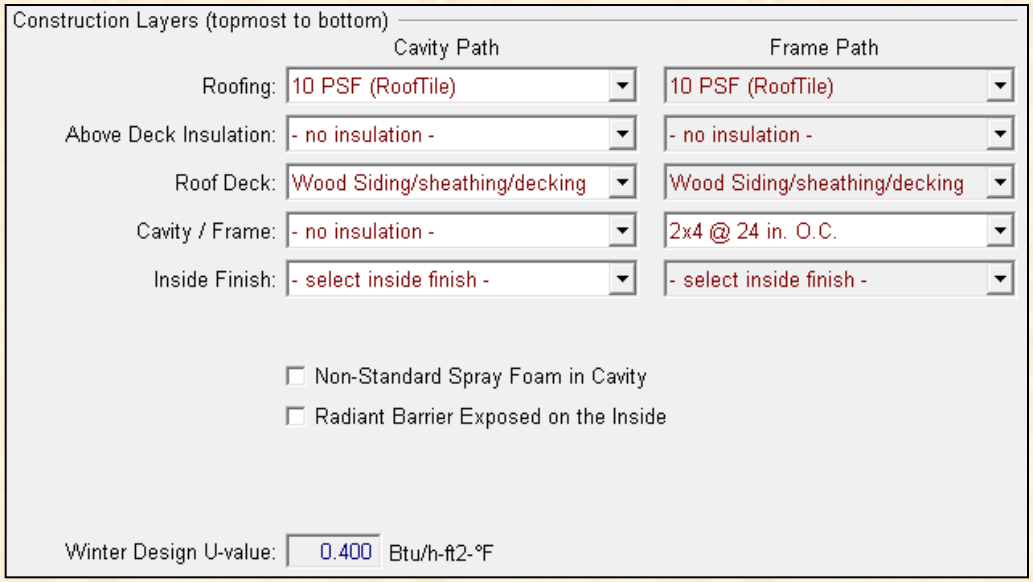
Title 24
2016
Standards

The Draft PV Credit – How It Would Work

Option 3, builder complies with no HPA and no HPW, but WITH PV Credit



Ceiling Insulation Still R-38 – 2013 Ceiling



Roof – No R-13 Cavity Insulation

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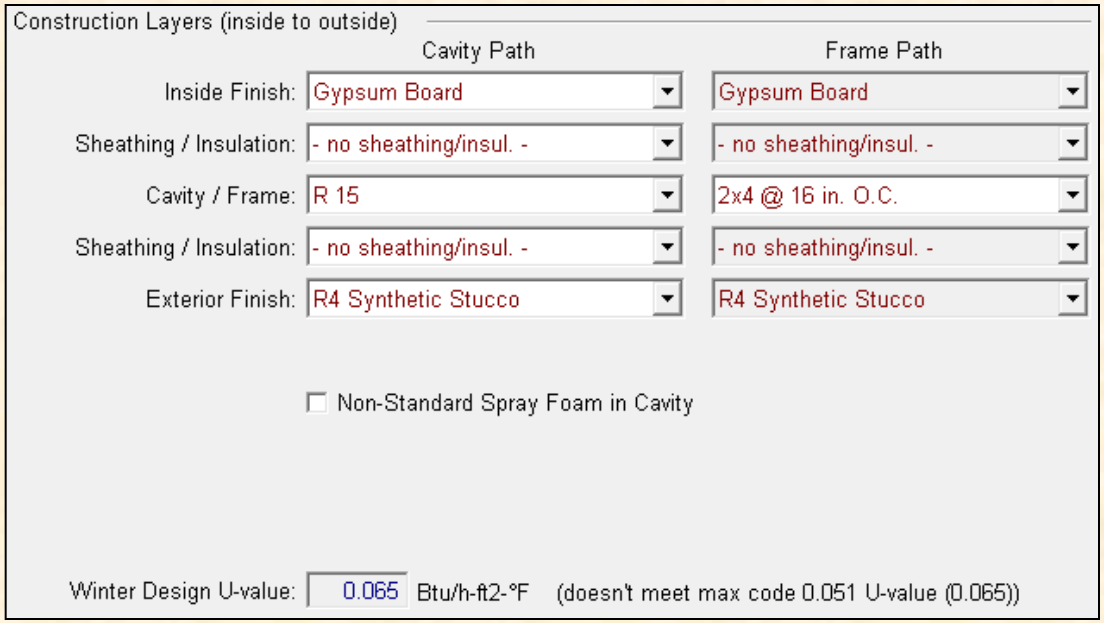
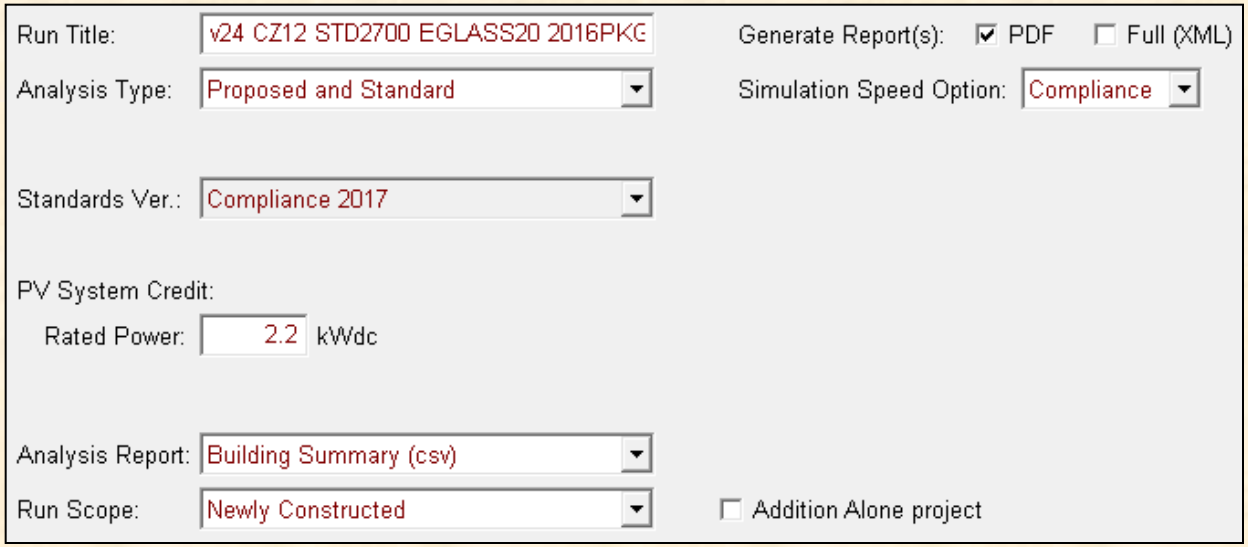
The Draft PV Credit – How It Would Work

Option 3, builder complies with no HPA and no HPW, but WITH PV Credit



Wall insulation R15 plus R4 – 2013 Wall



Minimum 2.2 kW PV system required

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The Draft PV Credit – How It Would Work

Option 3, builder complies with no HPA and no HPW, but WITH PV Credit

End Use	Standard Design Site (kWh)	Standard Design Site (therms)	Standard Design (kTDV/ft²-yr)	Proposed Design Site (kWh)	Proposed Design Site (therms)	Proposed Design (kTDV/ft²-yr)	Compliance Margin (kTDV/ft²-yr)
Space Heating	192	224.1	16.94	228	265.8	20.07	-3.13
Space Cooling	549		16.17	732		21.95	-5.78
IAQ Ventilation	141		1.15	141		1.15	0.00
Other HVAC			0.00			0.00	0.00
Water Heating		134.2	8.29		134.2	8.29	0.00
PV Credit						-9.87	9.87
Compliance Total			42.55			41.59	0.96
							2.3 %
Inside Lighting	1,300		11.11	1,300		11.11	
Appl. & Cooking	1,023	60.4	12.08	1,023	60.4	12.08	Result:
Plug Loads	2,630		21.67	2,630		21.67	PASS
Exterior	161		1.20	161		1.20	
TOTAL	5,996	418.6	88.61	6,215	460.4	87.65	

The Building complies with a margin of less than 1 TDV/ft2-yr

The Draft PV Credit – How It Would Work

Option 4, builder builds with HPA and HPW, and with PV installed, but proposed PV credit is used for installing more west-facing glass

The Draft PV Credit – How It Would Work

Option 4, builder complies with HPA, HPW, and PV, but with increased west-facing glass

Window Area:	15	ft2
Width:	3	ft
Height:	5	ft
Multiplier:	9	
NFRC U-factor:	0.32	Btuh/ft2-°F
Solar Ht Gain Coef:	0.25	
Source of Ufactor/SHGC:	NFRC	
Exterior Shade:	Insect Screen (default	

2016 Standard building without PV minimally complies with 540 sf of total and 135 sf of west-facing glass

2016 building with PV and standard window area has a compliance margin of about 10 TDV/ft2-yr:

End Use	Standard Design Site (kWh)	Standard Design Site (therms)	Standard Design (kTDV/ft²-yr)	Proposed Design Site (kWh)	Proposed Design Site (therms)	Proposed Design (kTDV/ft²-yr)	Compliance Margin (kTDV/ft²-yr)
Space Heating	192	224.1	16.94	192	224.1	16.94	0.00
Space Cooling	549		16.17	549		16.17	0.00
IAQ Ventilation	141		1.15	141		1.15	0.00
Other HVAC			0.00			0.00	0.00
Water Heating		134.2	8.29		134.2	8.29	0.00
PV Credit						-9.87	9.87
Compliance Total			42.55			32.68	9.87
Inside Lighting	1,300		11.11	1,300		11.11	23.2 %
Appl. & Cooking	1,023	60.4	12.08	1,023	60.4	12.08	Result:
Plug Loads	2,630		21.67	2,630		21.67	PASS
Exterior	161		1.20	161		1.20	
TOTAL	5,996	418.6	88.61	5,996	418.6	78.74	

The Draft PV Credit – How It Would Work

Option 4, builder complies with HPA, HPW, and PV, but with increased west-facing glass

Window Area:	39	ft2
Width:	6.5	ft
Height:	6	ft
Multiplier:	9	
NFRC U-factor:	0.32	Btuh/ft2-°F
Solar Ht Gain Coef:	0.25	
Source of Ufactor/SHGC:	NFRC	
Exterior Shade:	Insect Screen (default	

- With HPA, HPW, and PV, the builder can add another 216 square feet of west-facing glass, for a total of 756 sf of glass.
- The PV credit buys another 8% of glass-to-floor area to a total of 28% glass-to-floor area, if there are no other tradeoffs.

Standard building with extra west-facing glass and PV just passes:

End Use	Standard Design Site (kWh)	Standard Design Site (therms)	Standard Design (kTDV/ft²-yr)	Proposed Design Site (kWh)	Proposed Design Site (therms)	Proposed Design (kTDV/ft²-yr)	Compliance Margin (kTDV/ft²-yr)
Space Heating	192	224.1	16.94	204	237.2	17.98	-1.04
Space Cooling	549		16.17	810		24.97	-8.80
IAQ Ventilation	141		1.15	141		1.15	0.00
Other HVAC			0.00			0.00	0.00
Water Heating		134.2	8.29		134.2	8.29	0.00
PV Credit						-9.87	9.87
Compliance Total			42.55			42.52	0.03
							0.1 %
Inside Lighting	1,300		11.11	1,300		11.11	
Appl. & Cooking	1,023	60.4	12.08	1,023	60.4	12.08	Result:
Plug Loads	2,630		21.67	2,630		21.67	PASS
Exterior	161		1.20	161		1.20	
TOTAL	5,996	418.6	88.61	6,269	431.8	88.58	

Title 24
2016
Standards

The Draft PV Credit – Summary

1. It is a modest credit that is proportional to what is needed to trade away the HPA and HPW
2. A minimum of 2 kW PV system is required for this credit; more if the building is larger than 2,000 square feet, depending on the building size and the CZ
3. It is flexible, meaning it can be used to offset other building measures, such as water heaters and windows
4. However, if the credit is used for other measures, part or all of it may not be available for HPA and HPW tradeoff anymore
5. A building that takes full advantage of the proposed PV tradeoff will still be more energy efficient than a 2013 Standards compliant building
6. As more builders gain experience with HPA and HPW, there will be less need for the PV tradeoff
7. The credit is expected to go away in 2019 if there are suitable efficiency products available on the market that meet the HPA and HPW performance levels

Title 24
2016
Standards